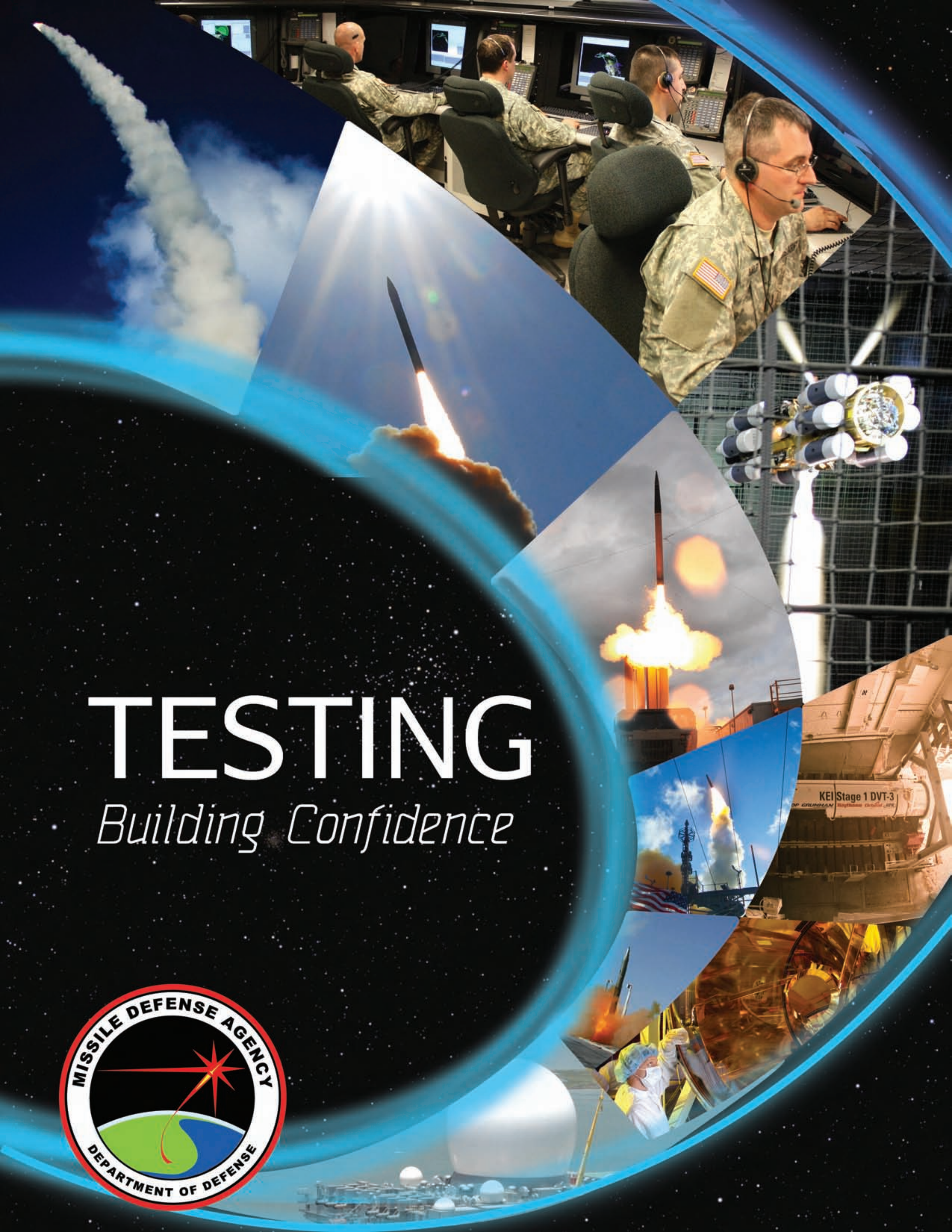


TESTING

Building Confidence

MISSILE DEFENSE AGENCY
DEPARTMENT OF DEFENSE

“FTG-05 is the largest most complex flight test MDA has ever conducted. It gave us a look at how the total system would actually operate. All of the system assets in the test were operated by people who man the system every day—soldiers at the consoles, sailors out at sea, and airmen who man the radars. We were able to exercise the techniques, the procedures, the doctrine, the communications system, and the sensors we will use when we actually deploy the system, all of which is necessary if we are to prove this to be an operationally realistic system.”

Lieutenant General Patrick O’Reilly following the successful GMD test in December 5, 2008.

Executive Summary

The United States is fielding a missile defense system capable of addressing the gap in U.S. defenses caused by the proliferation of short- and medium- range ballistic missiles and the growing interest of nations hostile to the United States in longer-range ballistic missiles. Not only has the number of countries holding short- and medium-range ballistic missiles increased over the last 30-plus years, but also the range, reliability, and accuracy of these missile systems have improved, creating greater risks for U.S. forces, interests, and allies throughout the world. Longer-range missiles capable of delivering chemical, biological, and nuclear weapons can cause massive loss of American lives and property. Ballistic missiles also provide a means for state and non-state actors to blackmail and intimidate the United States and its allies by potentially holding hostage hundreds of thousands of people.

By pursuing an innovative capability-based acquisition strategy, the United States successfully delivered the first increment of a layered, integrated missile defense system. The initial capability addresses short- and medium-range ballistic missiles using PATRIOT Advanced Capability-3 (PAC-3) missiles and the Aegis Ballistic Missile Defense (BMD) Standard Missile-3 (SM-3). Ground-based Interceptors (GBIs) enable engagement of intermediate-range and intercontinental ballistic missiles in the midcourse phase of their flight. These layers are integrated through an advanced and unifying Command, Control, Battle Management, and Communications (C2BMC) network. While testing of this initial Ballistic Missile Defense System (BMDS) continues, it is also evolving. Additional quantities of interceptors and sensors are being fielded as work continues to complete the design of new elements and mature technologies are being developed that will lead to an even more capable BMDS.

An important part of the BMDS development effort is ensuring the system will perform as designed when placed in the hands of the warfighter. The Missile Defense Agency (MDA), working with the independent test community and the Director for Operational Test & Evaluation, uses highly accurate modeling and simulation (M&S) tools as well as ground and flight tests to verify the functionality and operational effectiveness of the BMDS and understand the system's capabilities and limitations. Simulations that either model BMDS components and processes or connect, in a laboratory, with discrete pieces of real system hardware enable MDA to assess the performance of the BMDS numerous times in operational scenarios and make a statistical determination of BMDS effectiveness. Data collected during ground and flight tests anchor the missile defense models and validate their accuracy. The verification process is not yet complete, but the data collected to date give MDA confidence in the basic design of the BMDS, its hit-to-kill effectiveness, and its inherent operational capability. This assessment was recently buttressed by an independent test board that examined simulations and flight tests of the initial Aegis BMD capability and found Aegis BMD to be operationally effective and suitable for combat use.

Introduction and Goals

Background

The possession of weapons of mass destruction and ballistic missiles by potential adversaries is an urgent security issue for the United States and our allies. Effective missile defenses can contribute to U.S. non-proliferation objectives by devaluing ballistic missiles in the eyes of our adversaries as a useful delivery system for conventional munitions and WMD. Equally important, missile defense can help the country prepare for situations where diplomacy and non-proliferation initiatives have failed by deterring aggression and, after ballistic missiles are launched, by limiting damage locally or regionally.

In 1972, only nine countries possessed ballistic missiles. Today, the number of countries holding ballistic missiles has grown to over two dozen, and it includes hostile regimes with ties to terrorist organizations. The ballistic missile threat continues to grow in size and complexity. Potential adversaries are increasing short-, medium-, intermediate-, and long-range ballistic missile inventories even as they are developing more advanced and capable systems. Current trends indicate that adversary ballistic missile systems, with the integration of advanced liquid- or solid-propellant propulsion technologies, are becoming more mobile, survivable, reliable, accurate and capable of flying longer distances.

Fielding missile defense capabilities requires the combined efforts of MDA, the Office of the Secretary of Defense, the Joint Chiefs of Staff, the U.S. Unified Combatant Commands (COCOMs), other federal agencies, more than 17 major defense contractors, the Congress, and, increasingly, our allies and friends.

Mission

MDA's mission is to develop and field an integrated, layered BMDS to defend the United States, our deployed forces, allies, and friends against all ranges of enemy ballistic missiles in all phases of flight. A ballistic missile trajectory is divided into three distinct phases. In the boost phase, the ballistic missile's rocket engine thrusts the missile into space. Following boost, the missile coasts in the midcourse phase and may deploy a Reentry Vehicle (RV) and midcourse countermeasures. In the terminal phase, the missile reenters the atmosphere and accelerates to the target.

Goals

To achieve it's mission, MDA will simultaneously pursue six strategic goals:

1. Systematically increase knowledge through a more well substantiated, comprehensive, affordable, and executable BMDS test program.
2. Rapidly respond to the priorities and guidance of the warfighter and Office of the Secretary of Defense leadership.
3. Rigorously manage the achievement of all element cost, schedule, and technical performance objectives within the six established MDA baselines.
4. Implement the MDA Human Capital Strategic Plan.
5. Dramatically improve the cost effectiveness of MDA operations and the management of BMDS development through lean six sigma and other initiatives.
6. Enhance international cooperation and development of missile defenses in accordance with National Defense Policy.

Integrated System Development

The Initial Capability and Beyond

By late 2004 MDA fielded PAC-3 and Aegis BMD capabilities to protect against short- to medium-range ballistic missiles and the Ground-based Missile Defense (GMD) element to provide a limited defense capable of intercepting and destroying a ballistic missile launched from North Korea.

The integrated, layered defense that MDA is developing is intended to complicate adversary attack objectives, reduce the military utility of ballistic missiles, discourage the proliferation of ballistic missile technology, and bolster deterrence. In 2008, MDA increased the breadth and depth of fielded defenses by adding more forward-deployed, networked sensors and additional interceptors based at sea and on land. Future plans for the BMDS include deploying the first fire unit of the Terminal High Altitude Area Defense (THAAD) element in 2009 that will enable its engagement of short- and medium-range missiles during the terminal phase of flight and longer-range missiles in the early midcourse phase of flight. Enhancements to Aegis BMD will improve our ability to intercept short- to medium-range missiles in the midcourse phase of flight. Additionally, the evolution of the C2BMC will permit the United States and its coalition partners to pair any sensor with the best available weapon system to provide the most effective defenses against ballistic missile threats.

Our Acquisition Strategy

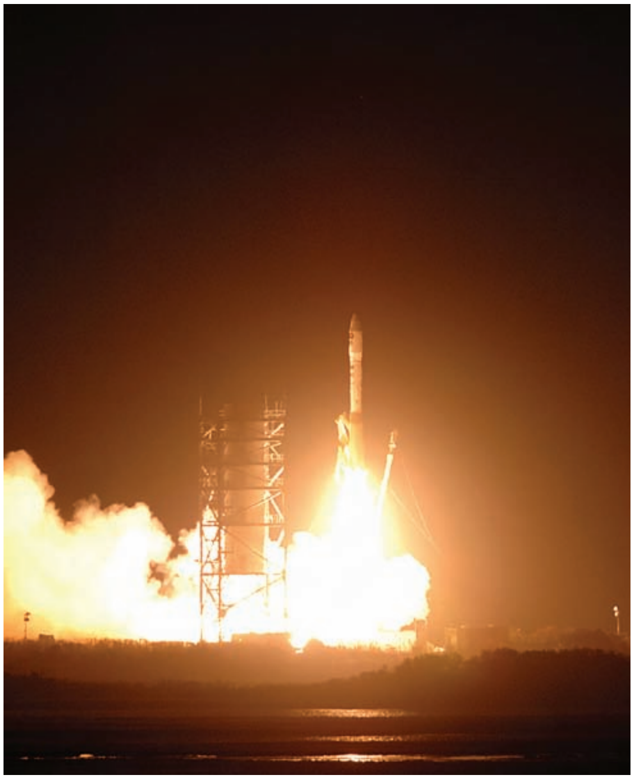
MDA's acquisition strategy incorporates an evolutionary approach based on developing an initial capability and evolving that capability through technology upgrades and the addition of new elements. The missile defense program is structured to deliver capability in "Blocks." Blocks are based on fielded capabilities that address particular threats and represent a discrete program of work. Once baselined, work cannot be moved from one Block to another without rebaselining. A Block is considered to be delivered once full capability delivery is declared for all the Engagement Sequence Groups (ESG) and delivery of the last piece of hardware associated with the build has been completed. When a firm commitment can be made to Congress, Blocks will have schedule, budget and performance baselines. Schedule delays, budget increases, and performance shortfalls will be explained as variances to the baselines.

Evolutionary, capability-based acquisition guides the aggressive research, development, test, and evaluation effort that is the foundation of MDA's program of work. MDA relies on capability-based acquisition to ensure it has the ability to respond to ballistic missile threats that are expected to evolve over time. With this approach, MDA focuses its development efforts on capabilities that are technologically feasible, respond to disciplined engineering analyses of warfighter desires and capability gaps, and address current and future threat environments. Using an evolutionary approach enables MDA to make changes to a Block while it is ongoing. Each Block may include numerous iterations, with each incorporating more advanced technology or changes dictated by testing or an emerging threat.

MDA's acquisition strategy also incorporates knowledge-based decision-making. MDA bases incremental funding commitments for each developmental effort on the achievement of a planned event, such as a ground or flight test, that measures an effort's progress toward its developmental goals. The benefit of knowledge-based funding is the ability to pursue multiple promising programs and redirect, stop, or accelerate any one program based on its actual performance. Ultimately, knowledge-based funding results in more efficient and responsible use of budgetary resources.

BMDS Capability Through 2008

Over the past few years, the United States has fielded an initial BMDS and is enhancing the system with additional capabilities in the form of deployed sensors, interceptors, and enhanced command and control.



At the end of 2008, the BMDS system architecture consisted of the following:

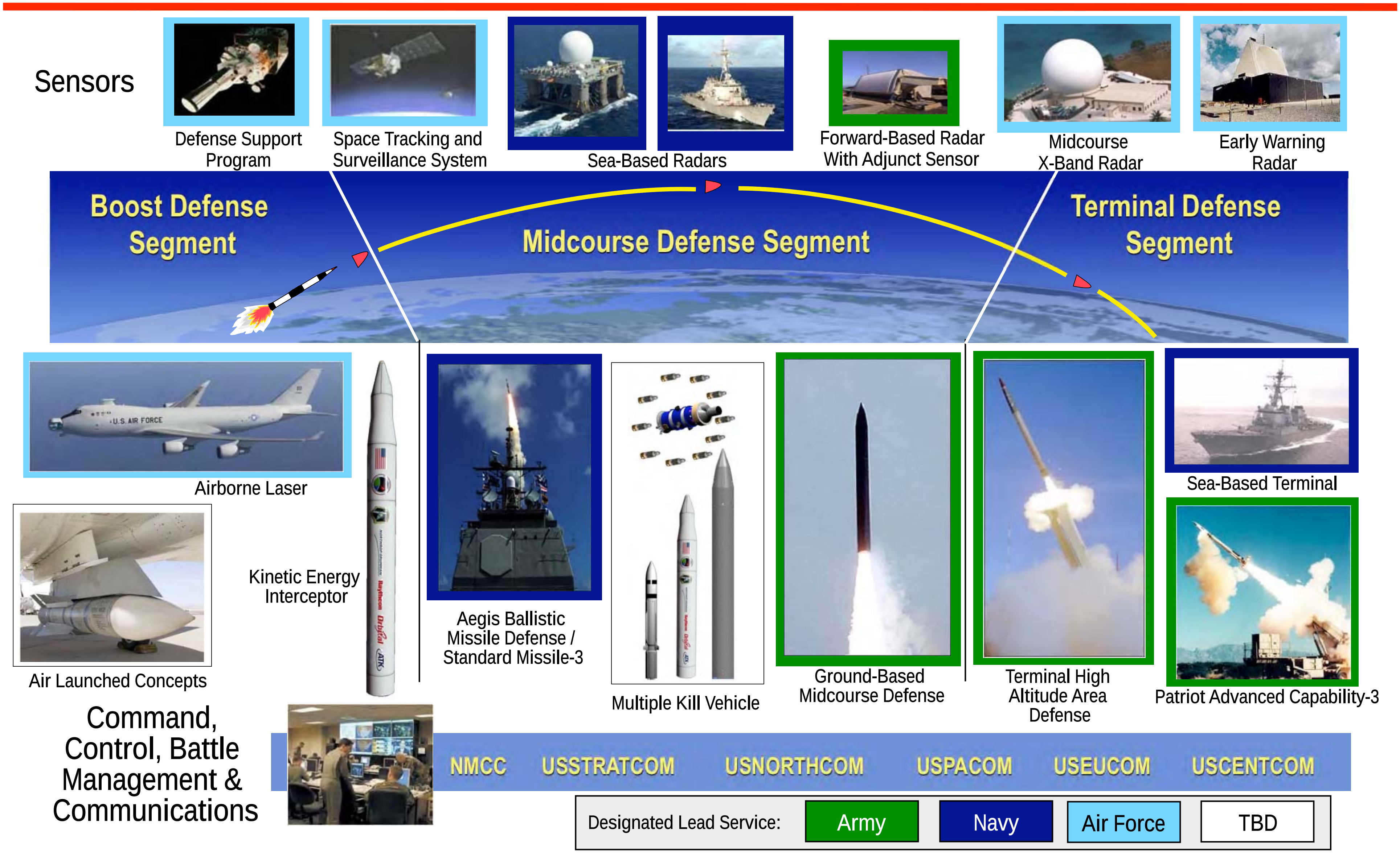
- 26 GBIs emplaced in silos in Alaska and California
- 32 Standard Missile-3 (SM-3) sea-based interceptors
- Three Navy Aegis cruisers and fifteen destroyers capable of engaging short- to medium-range missiles and performing the Long-Range Surveillance and Track (LRS&T) mission.
- 635 PAC-3 missiles.
- A Sea-Based X-Band (SBX) radar capable of providing discrimination to the system.
- Upgraded Early Warning Radars (UEWRs) in California and the United Kingdom and an upgraded Cobra Dane radar in Alaska
- Two Forward-Based X-Band Radars [AN/TPY-2 (FBM)] deployed in Japan and Israel.
- Elements of the C2BMC system were deployed to support five Combatant Commands and the National Military Command Center.

Systems Engineering

The Agency's Engineering Directorate integrates the layered BMDS, performs analysis of alternatives, and creates options for future BMDS architectures in direct support of U.S. Strategic Command's (USSTRATCOM's) Prioritized Capabilities List. The Prioritized Capabilities List presents warfighter desired future missile defense capabilities. Early in the BMDS capability design phase, engineers derive key data elements and critical design factors to guide engineering trade studies, system development, and all levels of component, element, and system testing, including the development of ballistic missile targets. Further, the Engineering Directorate, working with the Intelligence Community, produces the "common BMDS threat" to be used across the Agency's elements and components, as well as in BMDS test scenarios and architectures necessary for system design and capability assessment.

Systems engineers rely upon digital M&S and Hardware-in-the-Loop (HWIL) to support each phase in the development, test, and fielding of a Block of BMDS capability. M&S and HWIL are methods used to represent the BMDS first as a set of computer programs and then as discrete pieces of real system hardware connected together in a laboratory environment to accurately predict and represent the performance of various system configurations. Because these methods provide virtual duplication of BMDS components and processes in operationally realistic environments, their use can reduce cost, accelerate the acquisition schedule, and improve quality. Additionally, using M&S provides the ability to assess BMDS performance in scenarios that cannot be tested in a live flight test because of safety or fiscal constraints. The technical maturity of M&S is grounded in the model's ability to reflect system reality, which is locked in place by engineering technical assessments of BMDS performance in every test. This step by step technical process creates effective predictive models and builds confidence in system performance.

Integrated Ballistic Missile Defense System



Cumulative Quantities	2007	2008	2009
Weapons			
Ground-Based Interceptors (Long-Range Threat, Midcourse Defense)	24 Interceptors	26 Interceptors	up to 30 Interceptors
Patriot Advanced Capability-3 (Short- & Medium-Range Threat, Terminal Defense)	505 Interceptors	635 Interceptors	up to 727 Interceptors
Standard Missile Sea-Based Interceptors (Short- to Intermediate-Range Threat, Midcourse Defense)	21 Interceptors	32 Interceptors	up to 32 Interceptors
(Short- to Intermediate-Range Threat, Terminal Defense)		31 Interceptors	up to 67 Interceptors
Aegis Ballistic Missile Defense (Aegis Ballistic Missile Defense Ships with LRS&T Capability)	7 Destroyers 3 Cruisers	15 Destroyers 3 Cruisers	up to 16 Destroyers up to 4 Cruisers
Terminal High Altitude Area Defense (Short- to Intermediate-Range Threat, Midcourse Defense)			6 Launchers 4 Fire Control 1 Radar 8 Interceptors
Sensors			
Existing Defense Support Program Satellites			
Upgraded Existing Early Warning Radars	1 (Beale AFB, CA) 1 (Shemya, AK) 1 (Fylingdales, UK)	1 (Beale AFB, CA) 1 (Shemya, AK) 1 (Fylingdales, UK)	1 (Beale AFB, CA) 1 (Shemya, AK) 1 (Fylingdales, UK) 1 (Thule, GL)
Sea-Based X-Band Radar	1 Forward Operating Base (Adak, AK)	1 Forward Operating Base (Adak, AK)	1 Forward Operating Base (Adak, AK)
AN/TPY-2	1 AN/TPY-2	2 AN/TPY-2	2 AN/TPY-2

Command and Control Battle Management Communications

Combat Commanders:

U.S. Strategic Command (USSTRATCOM)
U.S. Northern Command (USNORTHCOM)
U.S. Pacific Command (USPACOM)
National Military Command Center (NMCC)
U.S. European Command (EUCOM)
U.S. Central Command (CENTCOM)

MDA International Strategy and

In order to protect national territories, deployed forces and our friends and allies most effectively, we must be able to operate the BMDS in different regions of the world. International partners are critical to the success of our mission. The Agency's International Strategy was approved by the MDA Director in 2007. This strategy establishes the vision, goals, and strategic objectives for strengthening BMD efforts with our international partners and guides our international engagements.

International Strategy goals direct all MDA international efforts, ensuring each effort advances the Agency towards accomplishment of its mission. These top-level goals are supported by strategic objectives that further define the goals and provide the foundation for implementation activities. While not all goals and objectives will be appropriate with each partner, the following goals lay out the general MDA approach. The MDA International Strategy goals are:

Outreach: Build relationships as enablers to achieve international missile defense goals and communicate the importance of missile defense by promoting worldwide BMDS by sharing information with allies and partners.

Capability and Interoperability: Promote missile defense capability and interoperability through appropriate means, such as fielding missile defense assets, identifying and integrating U.S. and partner assets and systems to create a global ballistic missile defense system, and promoting interoperability among U.S. and partner systems on bilateral and multilateral bases.

Technology: Identify and evaluate international technology in support of improved worldwide ballistic missile defense system capabilities.

Investment: Identify and execute investment opportunities with allies and partners.

Workforce: Shape a qualified and capable workforce to execute the MDA International Strategy.

International Programs

International engagement and partnerships help ensure a robust worldwide ballistic missile defense capability. MDA is committed to working with international partners and welcomes continued collaborative testing in the global community. MDA also continues to work in concert with the Combatant Commanders and the Services to support their missions and international goals.

MDA international partnerships and programs provide significant capability to the BMDS. These partnerships include six "framework" agreements, signed by the Secretary of Defense, to facilitate BMD cooperation with Japan, the United Kingdom, Australia, Denmark, Italy and, most recently, the Czech Republic. Additionally, cooperative activities are ongoing or under consideration with several other nations. Below are some highlights of MDA's international cooperation activities.

Current International Programs

In the Pacific theater, we will continue to enhance additional forward-based X-band radar capabilities in Japan and at other operating locations to meet warfighter needs. With the purchase of Aegis BMD and PATRIOT Advanced Capability-3 assets, and with our fielding of a transportable X-band radar at Shariki Air Base, Japan is fielding a multilayered system interoperable with the U.S. system.

Israel faces a number of adversaries armed with ballistic missiles and short-range rockets. Current U.S.-Israeli BMD cooperative programs include the Arrow System Improvement Program (ASIP), Arrow 2 missile co-production, Israeli Test Bed, and Short Range Ballistic Missile Defense (David's Sling). With the rapidly evolving threat of longer-range Iranian ballistic missiles, MDA provided an AN/TPY-2 radar to Israel on September 25, 2008.

Assuming host nation ratification of the missile defense agreement, the European Midcourse Radar (EMR) we plan to deploy in the Czech Republic would complement sensor assets deployed in the United Kingdom and Greenland and provide critical midcourse tracking data on threats launched out of the Middle East. The North Atlantic Treaty Organization (NATO) has committed to working with the United States to link this capability to any future NATO-wide missile defense architecture. The EMR would provide threat detection and tracking information to C2BMC and operate synergistically with forward-based deployed X-band radars and other missile defense capabilities. We are also awaiting host nation ratification to deploy ten interceptors in Poland to protect sections of Europe vulnerable to long-range attack from the Middle East. Other NATO missile defense assets may be deployed to protect European countries vulnerable to short- and medium-range ballistic missiles when integrated into the NATO command and control structure.

BMDS Test Strategy

The BMDS follows a simulation-based acquisition process that leverages collaboration with the BMDS Operational Test Agency (OTA) and the warfighter community throughout development and testing to ensure their requirements and participation are an integral part of BMDS testing. Using their criteria and those of the Agency's system engineers, all ground and flight tests provide data that MDA and the operational test community use to anchor M&S and to verify system functionality and operational effectiveness. Each system test builds on the knowledge gained from previous tests and adds increasingly challenging objectives.

Testing under operationally realistic conditions is an important part of maturing the system. The test program maintains a strong adherence to system engineering principles that include a "fly as you fight" planning process with the use of flight tests to verify the BMDS design and ground tests to discover design issues. MDA conducts flight tests using assets in operational configurations in order to execute increasingly complex, end-to-end tests of the system. As the flight test program progresses, each test becomes more operationally realistic, limited only by environmental and safety concerns. Comprehensive ground tests of the elements and components precede each flight test.

Concurrent Test, Training, and Operations

MDA is meeting the challenge of delivering a responsive operational capability concurrently with an on-demand test/training capability. To enable simultaneous test, training, and operation, the Agency has developed isolated communications networks for testing and training that are simulated with live-fly test targets, targets of opportunity, and high-fidelity simulated scenarios. MDA utilizes parallel networks that are physically and logically separated from the mission operations network.

Once the recommended program is implemented, the BMDS enterprise will be capable of simultaneously supporting global operations and at least one major system test or training event. When test or training events are focused on a single theater or region, a comparable event may be conducted concurrently in a second region or theater. Multiple other events not requiring the end-to-end BMDS infrastructure may also be scheduled on a "not to interfere" basis concurrent with major events.

System-Level Testing Process

With the evolution of the BMDS, testing has expanded beyond those of the individual elements into a system-wide approach. MDA utilizes a disciplined system engineering process to develop and integrate the BMDS into an effective, layered defense against ballistic missiles. MDA's system engineering process consists of the following steps: plan, define, design, build, test and verify, assess, and field, followed by the transfer of selected programs to a Service.

Testing is the foundation of the test, verify and assess steps. Testing provides critical data to determine whether BMDS elements and components are properly designed, built, and integrated, improves confidence that the BMDS will perform as designed, and supports capability delivery decisions. Test results also provide feedback into the plan, define, and design steps to identify areas for improvement.

M&S reflecting the physical BMDS system is key to MDA's system engineering processes. These tools accurately predict the performance of the system, element, or component under all operating conditions, including those that are off-nominal and beyond specification. MDA's confidence in M&S is based on a comprehensive Verification, Validation, and Accreditation (VV&A) process and incorporation of critical operational and test issues into the test program. The VV&A process establishes confidence by: verifying that BMDS M&S reflect the physical BMDS system; validating that the model of the component, element, or process represents its "real world" intended use; and accrediting that the model or simulation is acceptable for its specific purpose. MDA accomplishes model validation by designing test objectives that collect data on critical operational and technical issues. These issues are derived from system functionality and threat behavior that represent system issues or concerns, areas that must be demonstrated for performance verification, and areas of uncertainty where data should be gathered to validate simulations.

MDA also conducts capability-based operational testing in coordination with the Director of Operational Test and Evaluation (DOT&E). Operational testers and the BMDS- Operational Test Agencies (OTA) Team participate in MDA's planning, testing, and data analysis activities to integrate operational test and warfighter requirements into a system-wide test program, which enables independent operational assessments. MDA uses warfighter input to develop test objectives that evaluate new concepts of operations and exercise warfighter tactics, techniques, and procedures. The Integrated Master Test Plan, co-signed by the DOT&E and MDA Director, identifies test events across the Future Years Defense Program (FYDP).

MDA has initiated an integrated test design process that ensures a balance between data collection objectives, target capabilities, range constraints, instrumentation, ground test capabilities, and costs. Adaptive planning techniques add frequency and flexibility to testing and a well-developed, advanced mobile infrastructure supports integrated developmental and operational test objectives. To date, careful planning and thorough testing have produced data that gives MDA confidence in the basic design of the BMDS, its hit-to-kill effectiveness, and its inherent operational capability. MDA continues to work closely with the operational test community and warfighters to characterize the effectiveness and readiness of the system under operational and real world constraints.

The BMDS test review is being conducted in three phases. In Phase 1, MDA determined the body of data that is necessary for the Operational Test Community to validate BMDS models and simulations and the data needed to evaluate the system's operational effectiveness, survivability and supportability. In Phase 2, MDA will determine the test venues and scenarios that are needed to acquire the critical data identified in Phase 1. In Phase 3, MDA will identify the resources and the planning infrastructure, including targets and test ranges, needed to execute the test scenarios identified in Phase 2.

Tests and M&S are integral to verifying the functionality and operational capability of the BMDS. MDA made good progress in 2008 in validating the effectiveness of the existing BMDS and learned much about developing capabilities. The system will continue to evolve, and as it does, MDA's test program will evolve with it.

Warfighter Participation

MDA coordinates with USSTRATCOM and the Joint Functional Component Commander for integrated missile defense in assessing warfighter readiness to accept new BMD capabilities for operation. An important task of the Agency is identifying the series of tests, training, trial periods, wargames, and exercise events for use in building confidence in the operation and employment of the system capabilities being delivered. Included within these activities are Warfighter/Operational Test Agency Runs-for-the-Record that are part of element and system ground tests, capability and readiness demonstrations, BMDS simulation performance assessments, Tier I Combatant Commander exercises, and BMDS wargames. These events, along with Flight Test and Performance Assessments, provide data to address critical operations issues and performance and effectiveness measures identified in the "Force Preparation Campaign Plan." This plan assesses BMDS capability and forces for inclusion in the joint, global missile defense force structure.

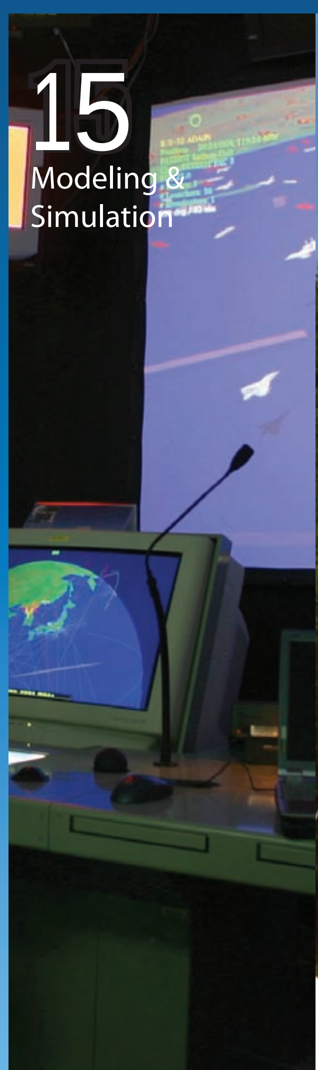
Throughout the development and fielding process, MDA provides hardware and software to the warfighter for new equipment training, unit training, and certification requirements before all required tests and integration events are completed. MDA also provides appropriate training facilities and logistics support for the capability, and MDA's Directorate of Engineering and element project offices will identify BMD system capabilities and limitations in the BMDS Handbook. Additionally, all equipment is operated in training and test modes, pending operator certification for tactical employment of the capability.

Summary

MDA has fielded an initial BMDS capability and is now strengthening it by increasing the number of fielded assets, developing new capabilities, and continuing the maturation of technologies that will contribute to future BMDS builds. Because test and evaluation is so important to the evolution of the BMDS, MDA placed great emphasis on testing in 2008 and produced notable accomplishments. MDA is currently developing capabilities for the future to counter emerging threats.

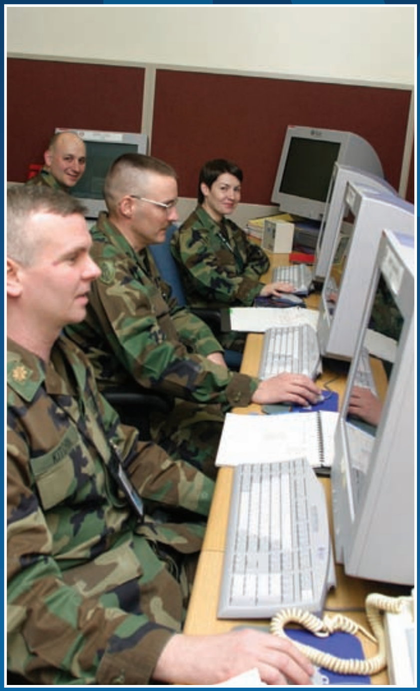
As the BMDS evolves, MDA must be ready to provide operational capability while continuing to develop and test the BMDS. To make this possible, MDA has added a concurrent test, training, and operations (CTTO) capability. This resource allows global operations to continue while test or training events are occurring.

Ballistic Missile Defense System Element and Component Details




21
Aegis Ballistic Missile Defense
23
Airborne Laser
25
BMDS Sensors
27
BMDS Space Systems
29
Ground-Based Midcourse Defense
31
Terminal High Altitude Area Defense
33
Multiple Kill Vehicles
35
PATRIOT Advanced Capability-3 & Medium Extended Air Defense System
37
Kinetic Energy Interceptor
39
Advanced Technology

Modeling & Simulation



MISSION

The M&S program is the centerpiece of MDA's effort to verify the functionality and operational effectiveness of the fielded BMDS capability. The program also supports other phases of the BMDS development and fielding program, including requirements definition, design, and the test planning that ensures tests collect the data needed for model validation.

The program's goal is to provide the digital and Hardware-in-the-Loop (HWIL) frameworks that present element model representations, of differing fidelities, in end-to-end digital simulations. The data derived from these simulations support MDA's efforts to deliver capability to the warfighter.

Program Description

MDA's M&S program is a single, integrated, synchronized effort that manages the integration of element models and simulations into BMDS models and simulations. System-level simulation of the BMDS is implemented on common M&S frameworks that accommodate both digital and HWIL representations of system functionality. MDA implements a rigorous M&S VV&A effort to provide confidence that the BMDS is being accurately represented.

MDA is currently engaged in a BMDS validation effort to identify test regions or test points where M&S uncertainty may exist. The purpose of this effort is to identify the sensitive data elements and specific critical engagement conditions in order to ensure that both the BMDS system and the elements are accurately represented so that we can better understand their performance.

Contributions to the BMDS

MDA uses M&S to support a variety of BMDS activities, such as concept exploration, wargames, performance assessments, ground and pre-mission testing, post-mission analysis, element and C2BMC integration, reconstruction of flight tests, training, and exercises, as well as how the BMDS may perform in a variety of operational scenarios. Models and simulations also assist in the development of future BMDS architectures by evaluating performance trade-offs, requirements allocation, and system timing.

Testing

The M&S program drives the number and objectives of BMDS tests. Similar to other DoD weapon programs, MDA uses simulations to make a statistical assessment of BMDS performance. This methodology allows MDA to run thousands of virtual tests of the BMDS and its components and processes in a variety of operational environments. Testing provides confidence that the assessment is accurate. To determine the number and objectives of required tests, the OTA, MDA's Engineering Directorate, element project offices, and other experts work together to determine all critical operational and technical issues that tests must examine and the number of tests required to examine the issues. Data collected during these tests verify and enable corrections to the models and simulations, ensuring the accuracy of their predictions.

2008 Accomplishments

- Defined a Digital Simulation Architecture and suite of digital simulation tools that support all intended uses of digital simulations and that integrate seamlessly with HWIL.
- Defined a Single Simulation Framework for HWIL that resolves existing incompatibility issues and integrates seamlessly with the Digital Simulation Architecture.
- Implemented a more robust VV&A program in support of MDA system-level events by incorporating key functions, verification and validation data elements and acceptability criteria, and by including post-flight reconstructions in campaign event interim verification and validation reports to support the development of a Campaign Accreditation Report.

Targets and Countermeasures

MISSION

The Targets and Countermeasures program provides threat representative, capability-based targets to support layered BMDS testing. Based on systems engineering assessments of realistic threat scenarios, the program acquires and launches targets with enhanced payloads to test, verify, and validate BMDS performance.

Program Description

The Targets and Countermeasures program develops, procures, and provides support for short-, medium-, and long-range capability-based targets equipped with enhanced payloads. Target and countermeasure configurations are based on requirements provided by the Deputy for Engineering. Configurations selected test the capabilities and limitations of the BMDS and anchor M&S.

In support of the BMDS test program, the Targets and Countermeasures program designs, prototypes, develops, certifies, improves, and conducts qualification testing of BMDS targets and associated payloads. Targets exhibit various degrees of threat emulation and have a broad range of performance characteristics and features that can be tailored to test multiple BMDS capabilities. Additionally, the program supports the reuse of existing government equipment, such as Minuteman II, Trident, and Lance rocket motors, by monitoring the condition of the equipment, refurbishing the equipment as needed, and assimilating it into targets for the BMDS test program.

The program continues development of the Flexible Target Family (FTF) 72-inch launch vehicle. The FTF initiative emphasizes commonality and modularity of components that can span across target systems and rapidly integrate to support MDA flight tests.

Contributions to the BMDS

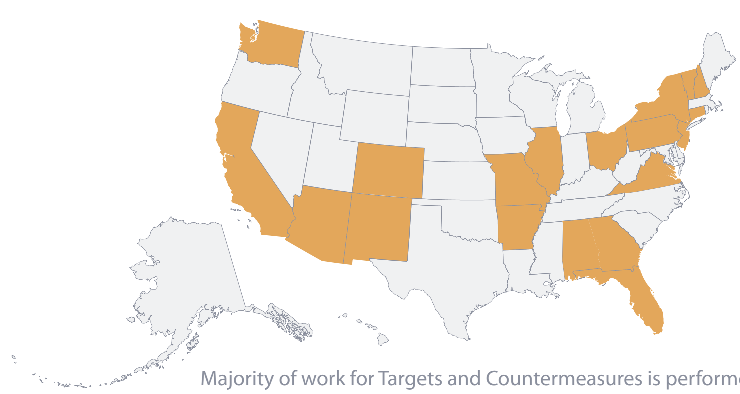
The Targets and Countermeasures program provides target systems to support operationally realistic BMDS testing. In parallel with providing targets for the ongoing BMDS test schedule, the program develops threat credible targets using MDA's capability-based engineering approach. In 2009, a new 72-inch diameter long-range target using FTF concepts will be available for the first time to support more complex testing and to replace the aging Strategic Target System (STARS) currently used for long-range testing. In addition to the FTF 72-inch target development, a new Extended-range Long-Range Air Launch Target (E-LRALT) and Aegis Readiness Assessment Vehicle (ARAV-C) are in development.

Testing

In 2008, the Targets and Countermeasures program delivered eight targets to support seven U.S. test events and one target to support the U.S.-Japanese cooperative effort. The program delivered one short-range ballistic target for an Aegis Sea Based Terminal test; two longer-range Aegis Readiness Assessment Vehicles; three long-range targets, two for GMD element tests and another that executed a highly successful fly-by of the Near Field Infrared Experiment Satellite (NFIRE); one air-launched medium-range target for THAAD's first engagement of this target type; and one sea-launched target of an original equipment manufacture target. The program also provided a medium-range ballistic target to test the engagement capability of a Japanese ship equipped with Aegis BMD.

2008 Accomplishments

- In addition to providing targets for eight test events, the program:
- Delivered the first of four sets of hardware components for the FTF 72-inch target that will be used in future long-range BMDS tests.
- Completed qualification testing of FTF 72-inch target components, marking the end of a three-year development process.
- Coordinated the buildup and delivered:
    - One newly-designed Modified Ballistic Reentry Vehicle-1 (MBRV-1)
    - Nine newly-designed Modified Ballistic Reentry Vehicle-2s (MBRV-2s)
    - Two Modified Ballistic Reentry Vehicle-3s (MBRV-3s)
    - One Generic Rest of World (GROW) Reentry Vehicle
- Conducted Critical Design Review for an advanced countermeasure design in preparation for BMDS flight testing.



Majority of work for Targets and Countermeasures is performed in the colored states.

Command and Control, Battle Management and Communications

MISSION

The C2BMC Element is the nerve center of an integrated layered missile defense. It ties the BMDS together by linking external sensors and weapons of independent Elements into a layered missile defense system. This networking of capabilities increases the footprint of the BMDS, resulting in greater performance and defensive capabilities.

C2BMC provides the flow of information critical to the defense of our nation, deployed forces, and friends, and allies. It provides warfighters at the strategic, operational, and tactical levels of command, along with our coalition partners, the capability to plan, monitor, and execute the missile defense fight by pairing any sensor with the best available weapon system.

Program Description

The C2BMC program balances development across multiple functions and includes key products such as the BMD Planner, Combatant Command-Command and Control (COCOM C2), Global Engagement Manager (GEM), and BMD Network. The BMD Planner provides capabilities to plan deployments of sensors and weapons systems to counter identified threats. The COCOM C2 component allows commanders to monitor the evolving battle and the status of defensive assets, which provides situational awareness at all leadership levels of command. Through its communication architecture, C2BMC links ground- and space-based sensors to detect, identify, track, and discriminate threats and manage and distribute essential operational data efficiently. The element's GEM provides the capability to globally integrate fire control by pairing the right sensors and weapons systems against multiple threats for the highest probability of kill and most efficient management of a relatively limited shot magazine. Each incremental delivery represents an improvement in capability and functionality and includes the software, hardware, network connectivity, operator training, and support needed to operate an integrated system.

Contributions to the BMDS

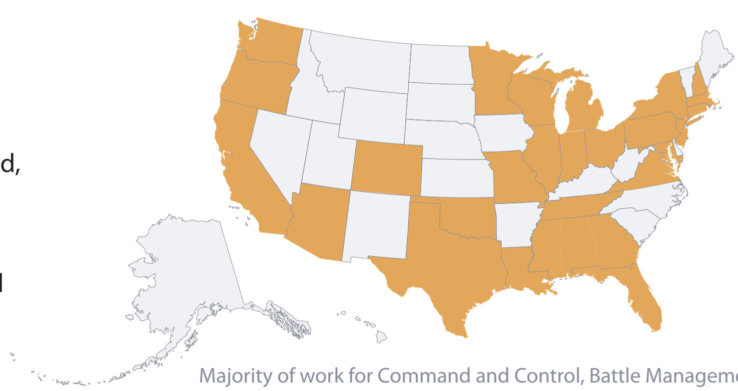
The C2BMC program puts the "system" in ballistic missile defense. It is a force multiplier, leveraging element capabilities to make the BMDS greater than the sum of its parts. It permits situational awareness, planning, fire control, and communication at the system level. Planned C2BMC evolutions will strengthen the BMDS by providing the ability to correlate threat tracks from multiple sensors via the network and create and distribute an engagement-quality system track for the BMDS weapons. The evolved C2BMC will also plan and process engagements that optimize the BMDS sensor resources and shot magazine by selecting optimum sensor – weapon combinations best suited to a specific threat and warfighter defense priorities.

Testing

The C2BMC program participates in all planned BMDS ground, flight, and HWIL tests in order to test and exercise all current and future capabilities. In 2008, C2BMC's support of ground tests included participating in numerous simulated tests and exercises. During a BMDS-level integrated ground test that demonstrated the BMDS ability to simultaneously execute multiple engagement sequence groups using both theater and strategic assets and a pair-wise ground test that focused on specific engagement sequence groups, C2BMC contributed to 86 Missile Defense System Exercise integration test runs, 60 Missile Defense System Exercise Qualification test runs, 53 dry runs, and 235 runs for the record. Flight test support included demonstrating C2BMC's ability to provide AN/TPY-2 (FBM) radar with focused search plans and precision cues from other BMDS sensors and supporting SM-3 simulated engagements on a remote track during a non-intercept flight test.

2008 Accomplishments

- Fielded new software for operational use which included a re-built BMDS planner with improved user interface, added Essential Elements of Information to allow more informed senior leader decision-making, added Parallel Staging Network to more rapidly field new software capabilities, and updated sensor management to implement precision cues and focused search plans.
- Fielded C2BMC capability at United States European Command, enabling the Command's ability to communicate with and manage transportable X-band radars.
- Transitioned the Network Enable Command and Control pilot project to the operational C2BMC system, providing situational awareness to any operational classified network user anywhere.
- Installed GEM hardware at Pacific Command.
- Implemented a 24/7 BMDS Network Operations Security Center.



Majority of work for Command and Control, Battle Management, and Communications is performed in the colored states.

Aegis Ballistic Missile Defense

MISSION

The Aegis BMD element provides engagement and long range tracking capabilities. Presently, all 18 Aegis ships, equipped with the certified, operational BMD-capable weapon system and armed with the Standard Missile-3 (SM-3), are capable of intercepting short- to medium-range, unitary and separating ballistic missiles in the midcourse phase of flight. To date, Aegis BMD has achieved 17 successful intercepts in 21 attempts.

Aegis BMD also serves as a forward-deployed sensor, providing early warning and Long Range Search and Track capabilities for intercontinental and intermediate range threats to support BMDS.

Program Description

The Aegis BMD program leverages and builds upon capabilities inherent in the Aegis Weapon System, Standard Missile, and Navy Command, Control, Communications, Computers, and Intelligence systems already installed on Navy ships. Initial modifications for BMD operations involved two principal changes: upgrading the

Aegis computer program to permit the SPY-1 radar to detect and track ballistic missiles and arming the ship with a BMD version of the SM-3.

The Aegis BMD capabilities are continuously evolving. In 2009, Aegis BMD will engage short- to intermediate-range ballistic missiles in the midcourse phase. Improved midcourse discrimination and hit-to-kill vehicle capabilities are also being developed to defeat more sophisticated ballistic missiles. Additionally, Navy and Aegis BMD are engaged in a joint effort to integrate the Aegis BMD capability with the Aegis Modernization Program's Open Architecture infrastructure. This program will expand most effectively and quickly the Aegis BMD capability potentially to the entire Aegis fleet of 84 ships. The United States is working with Japan to upgrade all four of Japan's KONGO Class Destroyers to the Aegis BMD operational Combat System configuration. These installations scheduled from 2007 through 2010, have completed two installations to date. The two countries are also jointly engaged in the SM-3 Block IIA Cooperative Development Program, which focuses on joint development of a 21-inch diameter variant of the SM-3 to intercept long-range ballistic missiles.

Contributions to the BMDS

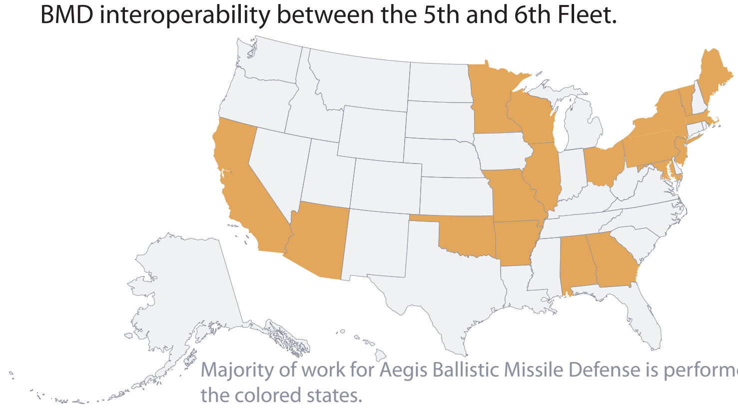
Aegis BMD extends the battlespace of the BMDS and contributes to an integrated, layered defense. Aegis BMD extends the range of the GMD element by providing reliable track data used to calculate firing solutions. In the 2009 time frame, Aegis BMD will coordinate engagements of short- and medium-range ballistic missiles with terminal missile defense systems. As tracking information is shared among these systems, the BMDS will have the opportunity to follow the engagement of a target during the midcourse segment with coordinated terminal engagements. As a ship-based system, Aegis BMD brings other advantages to the BMDS. It can move rapidly to theaters of operation without encumbrances and without placing a burden on U.S. transportation assets. It can also operate from locations at sea that are inaccessible to ground-based BMDS elements. Further, Aegis BMD can operate in international waters without the need for negotiating base access from other governments and without restrictions on its use.

Testing

Aegis BMD completed the MDA test process for its initial capability and transitioned that capability to the Navy in 2008. Testing began with development tests and concluded with combined development/operational tests. Based on an evaluation of tests and simulations that demonstrated Aegis BMD performance in numerous threat scenarios, the Navy's independent operational test agent found Aegis BMD to be "operationally effective and operationally suitable" and recommended transitioning Aegis BMD Block 04 to the Navy. The program has begun tests of a parallel evolution of Aegis BMD, which enables engagements during the endo-atmospheric terminal segment. In 2008, Aegis BMD successfully conducted its second test of the SM-2 Block IV, the missile that will be used in terminal engagements in the near-term. The tests demonstrated the ability of Aegis BMD to detect, track, intercept, and destroy a short-range ballistic missile using a dual SM-2 salvo. Aegis BMD also supported other BMDS-level tests, including a flight test of a Japanese Aegis BMD destroyer and a GMD flight test. In the GMD test, the SPY-1 radar sent information to GMD's fire control system, which integrated it with data collected by AN/TPY-2 (FBM) and Beale Upgraded Early Warning radars to provide the most accurate target trajectory for in the Ground-Based Interceptor.

2008 Accomplishments

- Successfully carried out a one-time, unique mission to shoot down an errant satellite.
- Conducted weapon system computer program certification and commenced shipboard installations and fielding of Aegis BMD Near Term Sea-Based Terminal capability.
- Took part in the first Fleet SM-3 operational firing.
- Participated in 5th Fleet Link Exercises, increasing BMD interoperability between the 5th and 6th Fleet.



Majority of work for Aegis Ballistic Missile Defense is performed in the colored states.

Airborne Laser

MISSION

The Airborne Laser (ABL) is a developmental boost-phase element of MDA's BMDS. When fully developed, the ABL, when deployed near the launch region, will defend the United States, its allies, and American forces deployed around the globe by detecting, tracking, and destroying all classes of hostile ballistic missiles soon after they are launched.

The ABL will represent the most advanced use of a directed energy airborne weapon system. ABL's Chemical Oxygen Iodine Laser (COIL) system is capable of producing a megawatt-class beam with a range of several hundred kilometers. To ensure the laser beam hits its target with sufficient destructive power, the system uses adaptive optics to compensate for beam distortion caused by atmospheric disturbance.

An ABL engagement begins when one or more of its six infrared sensors detect the heat from the plume of a hostile-launched missile. ABL's Track Illuminator Laser swings to the compass bearing indicated by the sensors and locks on to the missile to provide preliminary tracking data. The aircraft's onboard computer system processes and refines the data, triggering the firing

of the Beacon Illuminator Laser that finds the missile, settles on the aim point for the high-energy laser, and measures the amount of atmospheric disturbance between the aircraft and its target. Finally, the COIL fires to hit the target missile with sufficient energy to heat up its skin, causing it to self-destruct.

Program Description

The ABL program is designing, building, and testing an airborne laser system with unique capabilities to provide boost-phase defense against ballistic missile threats. ABL integrates three major subsystems–the High Energy Laser; Beam Control/Fire Control; and Battle Management, Command, Control, Communications, Computers, and Intelligence–into a modified commercial 747 aircraft. ABL also includes ABL-specific ground support equipment. The first ABL is a technology demonstrator. The ABL program measures progress by incrementally stepping through key knowledge points.

Contributions to the BMDS

The primary mission of ABL is to destroy hostile missiles during their boost phase of flight before they can deploy countermeasures or multiple reentry vehicles. This significantly increases the overall capability of the BMDS by reducing the number of targets faced by the other BMDS elements. ABL will also provide threat protection and enhance the performance of the other elements by providing early ballistic missile launch warning, launch and impact point prediction, and cueing to other BMDS elements via C2BMC. Numerous wargames designed to forecast BMDS interoperability continue to demonstrate that ABL's ability to detect launches and their launch points will also increase the probability of successful counterstrikes against aggressor missile launchers.

Testing

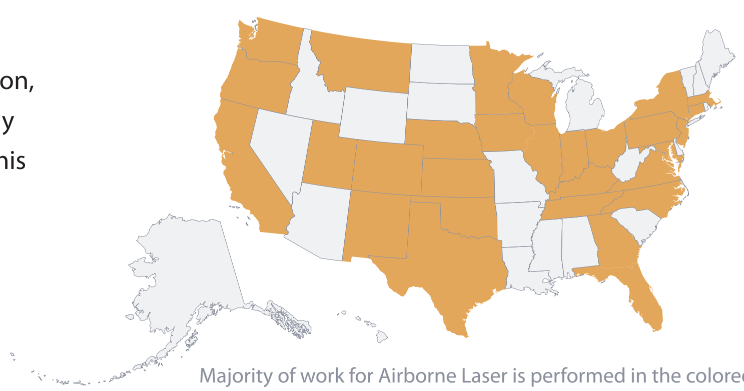
The overall ABL test program has three components: developmental test and evaluation, live fire test and evaluation, and operational test and evaluation. The program is currently engaged in the developmental test and evaluation phase. This phase applies a building block strategy that integrates and tests the low power and high power components of the ABL technology demonstrator and the fully integrated weapon system. This strategy incorporates extensive M&S analyses to characterize all aspects of ABL performance capabilities and identify and mitigate developmental risk. The current Developmental Test and Evaluation phase will culminate with a lethal demonstration against a threat-representative ballistic missile in the 4th quarter of fiscal year 2009.

During Live Fire Test and Evaluation, testing will focus on two key areas, lethality and survivability. Lethality will concentrate on ABL engagement timelines and the actual physics of the interaction of the laser beam with the target. Survivability tests are backed by ABL performance models and are designed to explore areas of aircraft vulnerability. Aircraft vulnerability investigations and assessments will begin in fiscal year 2009 and continue through fiscal year 2015.

The Air Force Operational Test and Evaluation Center initiated involvement in the ABL development program in June 2005. The Center will address operational test requirements when the program moves beyond the technology demonstration stage.

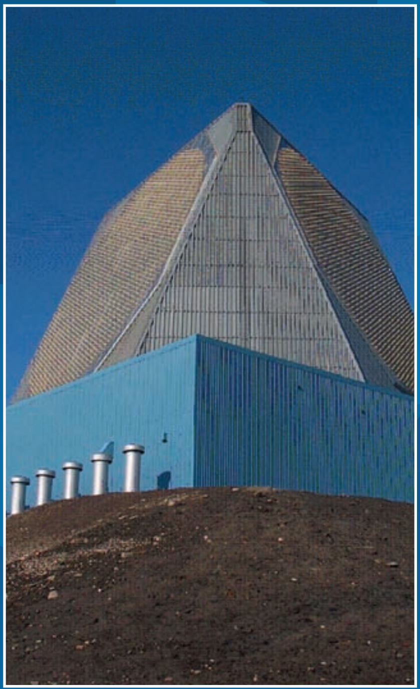
2008 Accomplishments

- Completed first light into the laser calorimeter on the aircraft demonstrating the High Energy Laser's operation during aircraft ground tests and verifying completion of the laser's installation, integration, and activation.
- Achieved first light through the Beam Control/Fire Control subsystem verifying completion of the subsystem's refurbishment and regression testing and demonstrating operation of the integrated weapon system during aircraft ground tests.



Majority of work for Airborne Laser is performed in the colored states.

Sensors



MISSION

MDA is developing and fielding a layered sensors architecture to provide continuous sensor track and discrimination of ballistic missiles in all phases of flight. The program acquires, fields, tests, and operates BMDS sensors and leverages data from non-MDA sensors, such as space infrared sensors.

Program Description

The BMDS Sensors program is responsible for the AN/TPY-2 radars, the Sea-Based X-Band (SBX) radar, BMDS-related operations for Air Force UEWRs, and the Cobra Dane Upgraded radar. In the future, the program will also upgrade and deploy the European Midcourse Radar.

The AN/TPY-2 radars and the SBX radar are ready to support the missile defense mission. The mission of the AN/TPY-2 radar is two-fold. Forward-based AN/TPY-2 radars provide improved homeland and regional defense; terminal mission radars are integrated into the THAAD Weapon System. Two operational forward-based radars are deployed in Japan and Israel respectively, and two radars are supporting THAAD program requirements, including flight tests, Limited Environment

Testing, and New Equipment Training. A fifth radar is supporting BMDS testing in both mission areas. The SBX radar is available for emergency activation, while it also supports BMDS flight and ground tests. The radar, which is mounted on a mobile, ocean-going platform, supports midcourse defense by performing high resolution cued searches, acquisition, tracking, and target discrimination.

The Sensors program is upgrading three Air Force Early Warning Radars to add a missile defense capability. The upgrades modernize radar hardware and software, but do not interfere with legacy missile warning and space tracking missions. MDA will transfer completed UEWRs at Beale, California; Fylingdales, United Kingdom; and Thule, Greenland to the Air Force in fiscal year 2011. The program is also upgrading the Cobra Dane Radar in Shemya, Alaska, to enable it to carry out the missile defense mission while retaining its legacy missions. It will be ready for transfer to the Air Force in fiscal year 2009.

Plans are also underway to upgrade a large, steerable, X-band phased array radar located at Kwajalein Missile Range. After all upgrades are completed, and once the host nation has ratified the BMD agreement, the radar will be deployed to a European location to provide midcourse discrimination capability in defense of the United States and Europe. The Sensors program plans to begin the upgrades in fiscal year 2009 and to deploy the radar in fiscal year 2013.

Contributions to the BMDS

The sensor architecture is a critical part of any successful engagement and incorporates advanced concepts that preserve interceptor inventory. Future initiatives include fielding improved discrimination algorithms, fusing sensor data, and providing kill assessments. These efforts will conserve resources, improve the track and discrimination data provided to BMDS weapon systems, and reduce the number of interceptors required per target engagement.

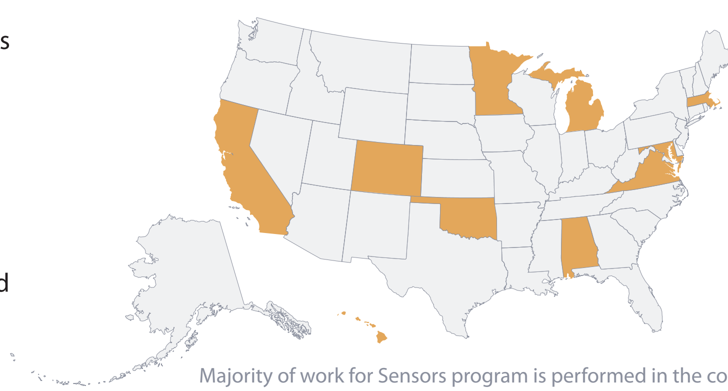
Testing

In 2008, Sensors participated in BMDS ground and flight tests and tests involving targets of opportunity. SBX, AN/TPY-2 (FBM), and the Beale UEWR participated in target tracking exercises and passed data to the GMD element's fire control node and C2BMC. Each radar collected data on long-range targets during Glory Trips conducted by the Air Force to confirm the functionality of U.S. intercontinental ballistic missiles. The Sensors program also assessed SBX tracking and advanced algorithm capabilities in four flight tests.

The Sensors program uses tests to verify sensor-to-shooter functionality and anchor models and simulations that predict sensor performance. Validated models and simulations are used to determine operating areas for respective radars. Testing and M&S efforts for 2009 will assess advanced software for the SBX, UEWRs, and the AN/TPY-2 (FBM) and assess the AN/TPY-2 (FBM) in performing its terminal mission. The Sensors program will also test the benefits of integrating external sensors as an operational asset. MDA established the External Sensors Laboratory (ESL) at the Missile Defense Integration and Operations Center (MDIOC) to define means to incorporate these sensors into the BMDS framework.

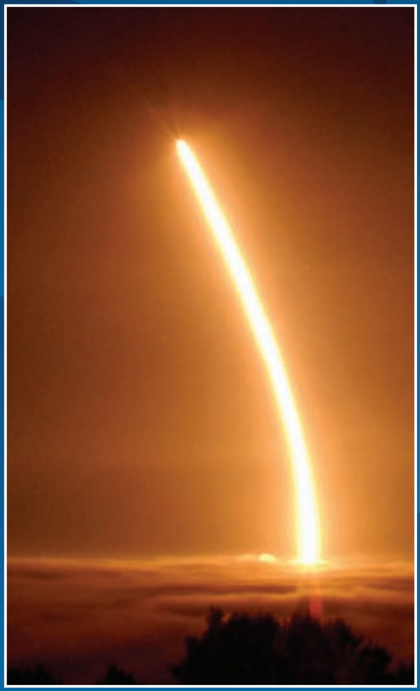
2008 Accomplishments

- Provided critical support to Operation BURNT FROST, the shoot down of an errant satellite.
- Transported, set up, and began operating the AN/TPY-2 (FBM) radar in Israel.
- Achieved early capability delivery for SBX.
- Successfully completed two BMDS-level flights that incorporated the AN/TPY-2 (FBM), SBX, and Beale radars on-line.
- Transitioned Cobra Dane sustainment to the Air Force.
- Completed Beale UEWR Operational Testing.
- Completed installation of new BMDS hardware at Thule.
- Began the transition and transfer of Beale and Fylingdales UEWRs to the Air Force.
- Demonstrated that External Sensors Laboratory could provide precision cue to AN/TPY-2 (FBM) radars.



Majority of work for Sensors program is performed in the colored states.

Space Sensors



MISSION

The MDA Space Applications Product Center is responsible for leading a multi-agency Department of Defense and industry team in developing, testing, and deploying space systems to detect and track ballistic missiles from launch through midcourse flight and eventual intercept or reentry. Mission objectives include developing space technologies that support MDA's space assets, including sensors, space qualified components, optics, and algorithms. The Space Applications Product Center will play a lead role in any future space initiatives undertaken by MDA and facilitate the integration of external Overhead Non-Imaging Infrared sensors.

Program Description

The Missile Defense Space Experimentation Center (MDSEC), Colorado Springs, CO, is the integration center for MDA's Space Applications Product Center. The MDSEC is responsible for operating the Space Tracking and Surveillance System (STSS) and NFIRE satellites and for conducting space-related

research, development, test, and evaluation activities in support of the missile defense mission.

In 2009, NASA will launch two STSS low-earth-orbit research and demonstration satellites with infrared and visible sensors to track missile launches, midcourse travel, and atmospheric reentry. Each satellite uses an acquisition sensor for missile launch detection and a movable tracking sensor to follow midcourse objects in space. The STSS satellites will demonstrate the ability to pass missile tracking data to system interceptors with the accuracy and timeliness necessary to enable successful target intercepts. MDA will be able to make more informed decisions regarding the development and deployment of satellites for the operational architecture from the data obtained from these demonstration satellites.

The NFIRE satellite launched in April 2007 will reduce the risk to next-generation BMDS interceptors on land, at sea, and in space by collecting signature data on boosting ballistic missiles at close range and in real-world conditions. The data collected will anchor design tools for future interceptor hardware, software, and algorithm development. NFIRE also will provide MDA with early experience coordinating space assets with BMDS flight tests.

Contributions to the BMDS

Space sensors will play a significant role in a global missile defense capability by providing continuous tracking of ballistic missiles and passing tracking information to BMDS radars and interceptors. Accurate tracking data provided by space sensors will increase the robustness of the BMDS, allow additional and earlier intercept opportunities, and provide coverage in locations inaccessible to BMDS radars.

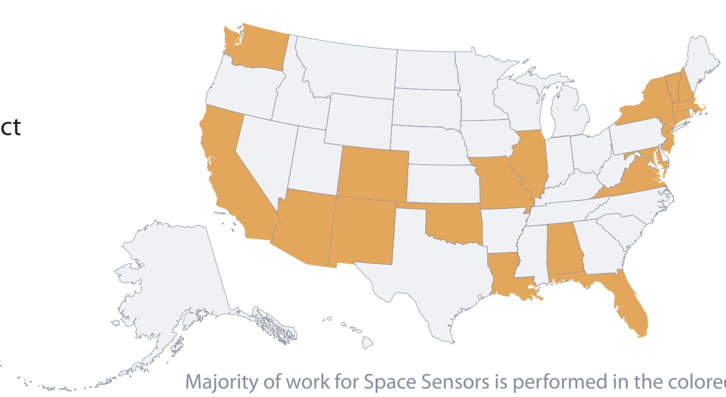
Testing

Testing activities during 2008 included thermal vacuum testing of both STSS satellites and acoustic testing of the stacked satellites and the launch vehicle's orbital insertion stage. The MDSEC also simulated STSS 24/7 test operations with the Air Force Satellite Control Network, exceeding a 95 percent contact goal.

The NFIRE collected first-of-a-kind high resolution plume and hard-body data of a boosting intercontinental ballistic missile (ICBM) at a distance of about eight kilometers. The data will anchor plume codes and algorithms that allow missiles to target the hard-body of an enemy missile rather than the hot gases produced by the missile's boosting motors during boost phase intercepts.

2008 Accomplishments

- Conducted STSS Crew Readiness, Day of Launch, Deployment, 72 - hour Day-in-the-Life Operations, and Contingency Operations exercises in preparation for fiscal year 2009 Launch.
- Conducted NFIRE/MDSEC 24/7 on-orbit operations in support of NFIRE testing
- Conducted data collection against dedicated ballistic missile targets (NFIRE 2A and 2B)
- Successfully performed NFIRE laser crosslink communications with German Satellite TerraSar X to demonstrate that a high-rate data link can be established between Low Earth Orbit satellites in dissimilar orbits.
- Developed/Operated MDSEC Integration Laboratory to support MDA Space Test and Experiments.
- Defined experiment processes for the use of the STSS demonstration satellites. Executed initial BMDS integration experiments with space sensor data, including system track generation improvements. Demonstrated the interface between STSS satellites and the BMDS X-Lab.
- Delivered initial capability of MDSEC Information System (MIS), which includes interconnectivity and access to space sensor data and products for BMDS test and experiments.
- Enhanced Management Information Systems capabilities, including access to Overhead Non-Imaging Infrared sensor data, net-centric access to sensor data, and the development of web-based tasking of STSS and NFIRE sensors.
- Supported the External Sensor Lab's work to process data from Overhead Persistant Infrared sensor systems for potential integration into the operational BMDS.



Majority of work for Space Sensors is performed in the colored states.

Ground-Based Midcourse Defense

MISSION

The GMD program is developing and fielding a capability to defend the United States against intermediate- and long-range ballistic missile attacks in the midcourse phase of flight.

Program Description

The GMD element is primarily composed of a Fire Control and Communications component and ground-based interceptors (GBI). In addition, it relies upon a variety of satellites and radars, such as the Cobra Dane radar, UEWRs, SBX radar, AN/TPY-2 radars, and the Aegis AN/SPY-1 radar, to obtain information on launch warning, tracking, targeting, and discrimination. The sensors provide data via C2BMC and directly to GMD's Fire Control and Communications component. GMD also receives sensor data from Cobra Dane, UEWR, and SBX sensor platforms that is provided directly to GMD without being processed by C2BMC.

GMD's Fire Control and Communications component enables the warfighter to understand and assess the threat situation, make informed decisions,

and feed intercept planning data to GBIs. The component consists of the hardware, software, and communications systems necessary for planning, tasking, and controlling the GMD components during threat engagements, including mission success evaluation. It collects data from all missile defense sensors, links communications among all components, connects GMD to the overall BMDS, and allows military and civilian authorities to mount a coordinated defense against a limited ballistic missile attack.

The GBI, comprised of a booster vehicle and an exoatmospheric kill vehicle (EKV), launches based on threat identification and command authority. The booster carries the EKV to the point where it can complete the engagement and releases the EKV. The EKV acquires the target, performs final discrimination, and steers itself to collide with the enemy warhead.

Contributions to the BMDS

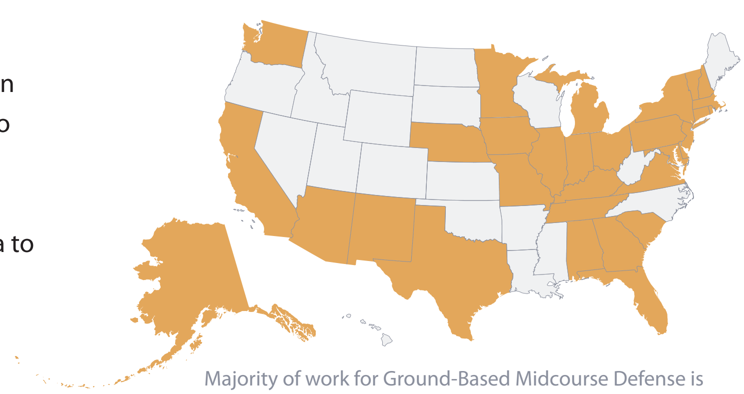
As the only fielded BMDS element capable of engaging intercontinental ballistic missiles, GMD is a key component of the BMDS that provides protection for the United States. GMD is also contributing to the development of advanced BMDS capabilities by increasing data sharing across the system to more effectively manage BMDS assets and prepare the BMDS to engage next generation threats.

Testing

The GMD program continues to demonstrate GMD's midcourse hit-to-kill capability in a series of ground and flight tests with increasing operational realism and BMDS integration complexity. In June 2008, the GMD HWIL Laboratory participated in an integrated ground test that assessed BMDS functionality and interoperability under stressing conditions with simulated concurrent theater, regional, and strategic attacks. The GMD program also executed a flight test, with soldiers at the controls, in which C2BMC processed complex data from multiple sources simultaneously and developed an engagement solution using SBX data that enabled the GBI to intercept a threat-representative long-range ballistic missile target. GMD's HWIL Laboratory participated in a post-flight reconstruction of this test in December 2008 to provide data to support validation of BMDS models and simulations.

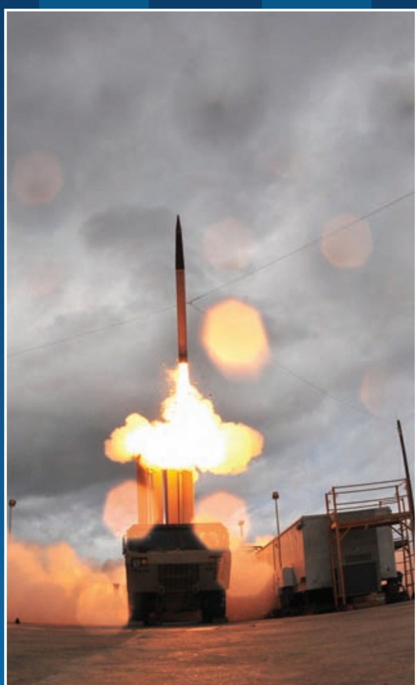
2008 Accomplishments

- Integrated the SBX and demonstrated its target engagement and tracking capability in a successful flight test.
- Participated in successful GT-03 ground test campaign to demonstrate capability to perform the mission in multi-threat scenario.
- Supported the warfighter by providing development assets for contingency operation.
- Provided analysis support in the shoot down of a failed satellite.
- Continued improved system discrimination development employing AN/TPY-2 (FBM) Radar discrimination data and the sea-based XBR.
- Secured signed site agreements with two European countries.
- Accelerated European capability development and testing by one year. Key flight tests for European Capability development were moved one year earlier in the testing schedule.
- Improved capability to conduct Simultaneous Test and Operations.
- Improved fidelity of GMD Crew System Trainers.
- Emplaced four operational GBIs and associated equipment.
- Completed construction of a third operational launch facility at Vandenberg Air Force Base, California.



Majority of work for Ground-Based Midcourse Defense is performed in the colored states.

Terminal High Altitude Area Defense



MISSION

The ground-based THAAD element deepens and extends the BMDS battlespace by providing the opportunity to conduct endo-atmospheric and exoatmospheric engagements of short- and medium-range ballistics missiles that were not destroyed in earlier phases of their flight. THAAD defends large land areas by relying on the early detection and tracking capability of BMDS sensors and the ability of the THAAD interceptor to engage a target at long range and high altitude. Additionally, THAAD is mobile, making it rapidly deployable to theaters of operation for protection of forward-positioned military forces as well as friends and allies.

Program Description

THAAD batteries consist of four principal components: truck-mounted launchers, interceptors, fire control/communications, and the AN/TPY-2 terminal mode (TM) radar. THAAD launchers store and transport interceptors and can be rapidly fired and reloaded. The battery's fire control and communications component

provides the element's battle planning, fire control, and communication backbone, linking THAAD to the BMDS and other air and missile defense networks used by the Services. In addition to element-specific components, THAAD can utilize BMDS sensors to detect targets and cue the AN/TPY-2 (TM) radar, which then tracks the target and guides THAAD interceptors during flight.

Contribution to the BMDS

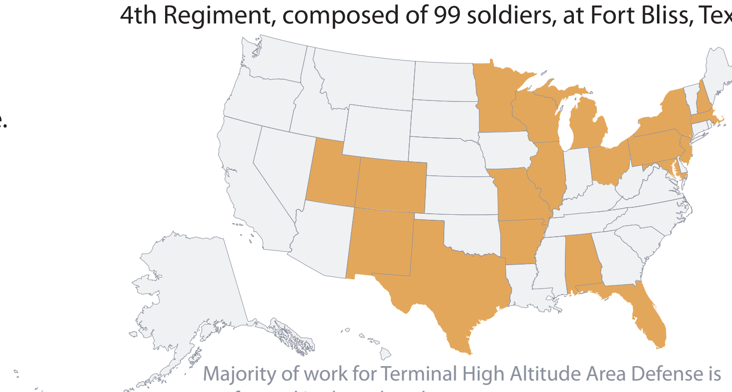
The THAAD element enables the BMDS to protect friendly forces from ballistic missiles engaged during the terminal phase of their flight. With cuing from BMDS C2BMC, THAAD is able to engage ballistic missiles at higher altitudes and longer ranges and protect larger land areas than other terminal elements.

Testing

The THAAD Project Office is using ground tests, flight tests, and M&S to ensure that THAAD's design is translated into an effective and reliable BMDS element. The Project Office is conducting a series of ground tests to assess the operation of THAAD components in various environments, ensuring that a battery can operate through extreme weather conditions and various nuclear, chemical, and electromagnetic environments. The THAAD element is also participating in MDA's Ground Test Campaign to verify its interoperability with other BMDS elements and to demonstrate its contribution to the BMDS. THAAD has successfully completed eight flight tests, five of which were intercept tests, to verify its performance under stressing conditions and to anchor M&S. Additionally, contractors have integrated tactical hardware and software with M&S and are carrying out thousands of runs to predict THAAD's performance under numerous threat scenarios. During 2009, M&S will predict and flight tests will demonstrate THAAD's intercept of targets at low altitudes and its engagement of targets with low infrared signatures. The data from tests and simulations will allow an independent test group, in 2009, to assess whether THAAD is capable of defeating major threats using realistic engagement doctrine.

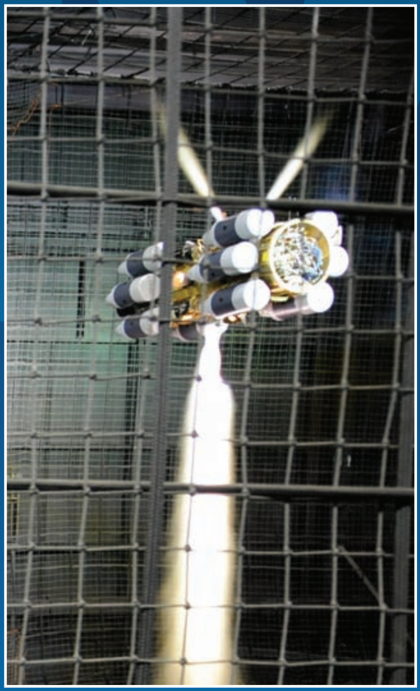
2008 Accomplishments

- Carried out Live Fire Test and Evaluation activities designed to assess missile lethality and operational effectiveness against designated targets.
- Conducted the first phase of Fire Control/Communication and radar government block qualification tests to demonstrate component mobility and automotive safety.
- Accomplished Electromagnetic Environmental Effects tests that consider whether the interceptor and launcher are designed to withstand such effects that may be produced in an operational environment.
- Performed insensitive munitions and final hazard classification tests to determine if hardware or software safety hazards exist that should be mitigated or controlled to avoid loss of life or serious injury to personnel, facilities, or equipment, or that could have an adverse impact on mission capability or mission operability.
- Executed seven military exercises and wargames that provided risk mitigation for ground tests, multi-national training venues, joint BMDS-level planning opportunities, and occasions to practice joint BMDS-level tactics, techniques, and procedures, as well as concepts of operation.
- Carried out a successful flight test inside the atmosphere against a spin-stabilized, simple separating target.
- Conducted tactical operations training throughout 2008 that considered THAAD's employment within the strategic context of the BMDS and Army environments.
- Began integrating soldiers with the THAAD weapon system by having them participate in THAAD-specific government ground and flight tests, BMDS integrated tests, and battery new equipment training.
- Supported Forces Command activation of Alpha Battery, 4th Regiment, composed of 99 soldiers, at Fort Bliss, Texas.



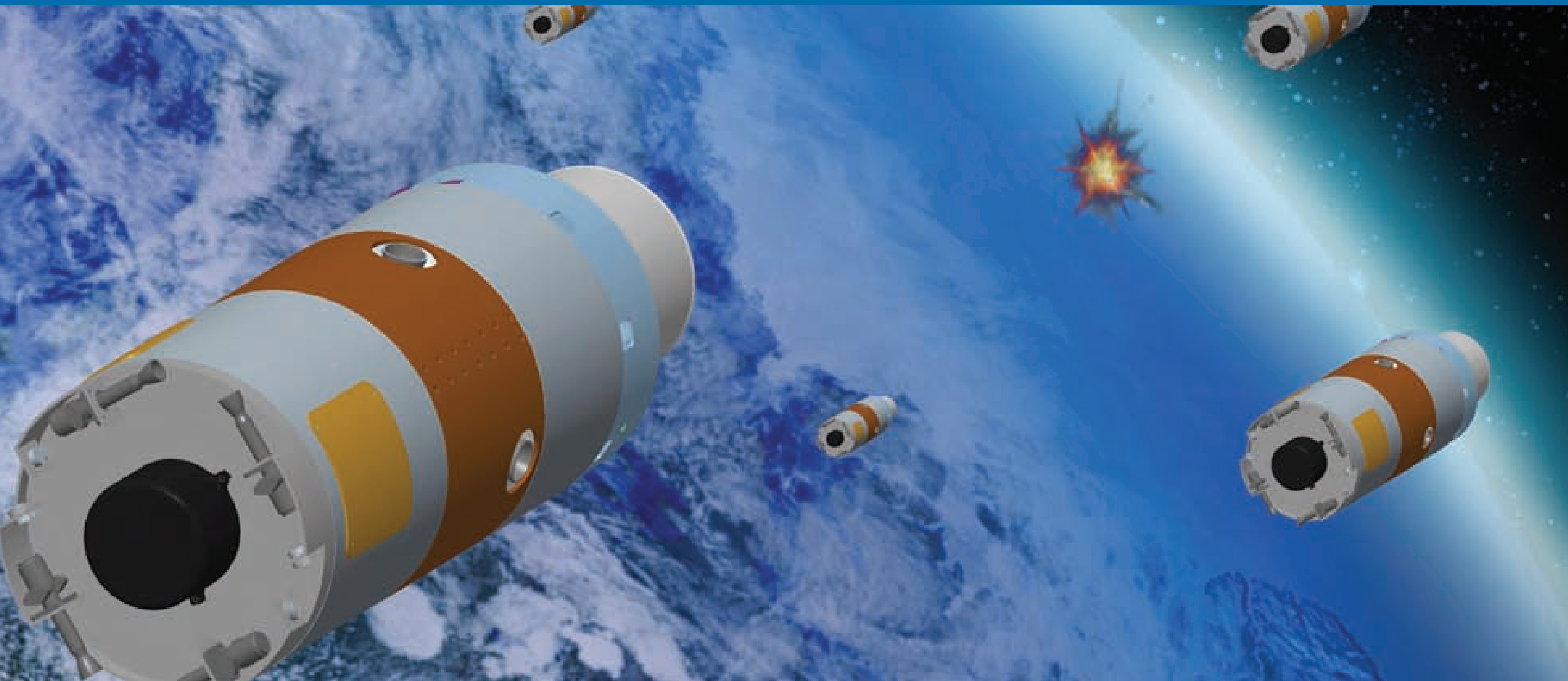
Majority of work for Terminal High Altitude Area Defense is performed in the colored states.

Multiple Kill Vehicle



MISSION

The mission of the Multiple Kill Vehicle (MKV) is to counter complex ballistic missile threats during the midcourse phase of their flight with multiple kill vehicles launched from a single interceptor. During midcourse flight, the enemy may attempt to disguise their warhead or deploy decoys and other types of debris around their warhead in an effort to confuse BMDS sensors. MKV payloads do not require the BMDS to pinpoint a single lethal object within a threat cluster. Instead of pairing one kill vehicle per interceptor, the MKV allows a single interceptor to deliver several kill vehicles that can attack multiple threat objects within the threat cluster. The objective program will provide MKV capability to all midcourse interceptor elements, such as Ground-Based Interceptors, Standard Missile-3 interceptors and Kinetic Energy Interceptors.



Program Description

The BMDS Kill Vehicles program is developing the MKV, a force multiplier that will increase the fire power of all land- and sea-based interceptors that engage ballistic missiles in the midcourse phase of flight. The program's strategy for kill vehicle development employs competitive prototyping of alternative multiple kill vehicle configurations, allowing the agency to leverage common elements and components.

The program includes kill vehicle payload development, integration, test, demonstration, and deployment throughout the BMDS by 2017. The MKV test program will progress from M&S to HWIL testing, to payload hover and flight testing, and finally to system-level flight tests at the Pacific test ranges.

Contributions to the BMDS

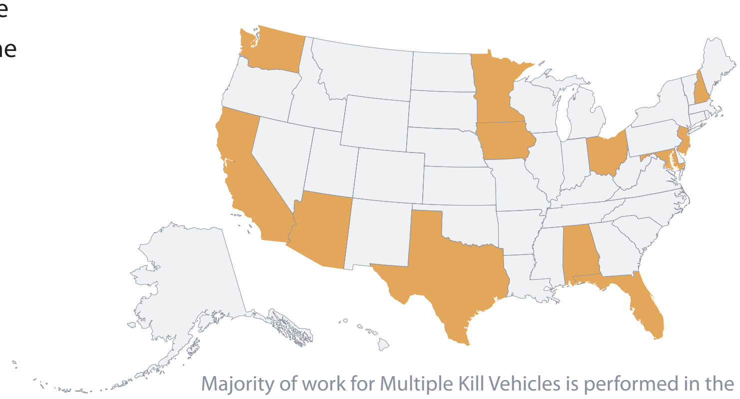
MKV capability is an integral component of a broad BMDS strategy for defeating adversaries that dramatically alters the battle space in favor of the defense. The MKV payload will receive the best available targeting data in-flight through the BMDS C2BMC, allowing the payload to attack and destroy a large number of objects in a threat cluster. This strategy reduces the number of interceptors required to engage all potential threat objects during each engagement, permitting more efficient use of the BMDS interceptor inventory.

Testing

The BMDS Kill Vehicles program has completed a simulation and two ground tests to verify technology important to one contractor's MKV concept. In May 2008, the program successfully demonstrated the engagement management algorithms for the concept's MKV carrier vehicle during a modeling and simulation exercise. The successful demonstration was a necessary precursor to proving that the carrier vehicle can manage its cargo of kill vehicles in the time needed to complete a real mission against a complex target. This test was followed in August 2008 by a series of static, hot-fire tests that proved a key component of the carrier's propulsion system met performance requirements. The final test of 2008 examined the ability of the MKV to hover under its own power and proved its capability to recognize and track a surrogate target in a flight environment. During the test, the MKV propulsion system demonstrated that it could maneuver the MKV while it tracked a target. The MKV was exercised in a Future Epoch Wargame Event at Colorado Springs in October 2008, allowing the warfighter to assess the use of MKV to defend the homeland from increasingly complex threats and countermeasures.

2008 Accomplishments

- Demonstrated the first Multiple Kill Vehicle end-to-end simulation operating in an open architecture modeling framework.
- Completed calibration of an operational pathfinder carrier vehicle seeker, a major milestone in developing new technology needed for MKV target tracking and discrimination.
- Completed System Requirements Reviews for integrating MKV with Ground-based and Kinetic Energy Interceptors.
- Conducted U.S. only SM-3 Cooperative Development System Design Review.
- Cooperative Development System Design, demonstrating that the missile requirements development, methodology, and progress met the objectives in order to gain Joint Steering Committee approval to proceed to Preliminary Design Review.



Majority of work for Multiple Kill Vehicles is performed in the colored states.

PATRIOT Advanced Capability-3

MISSION

The PATRIOT System equipped with the Patriot Advanced Capability (PAC)-3 missile is the most mature element of the BMDS. Operational with the U.S. Army, PAC-3 is a land-based system built on the proven PATRIOT air and missile defense infrastructure. PATRIOT is essential to defense of high value assets and maneuver forces, both friends and allies, against today's threats and future threat evolution over the coming years. In March 2003, the Under Secretary of Defense approved "PAC-3 Transfer and Medium Extended Air Defense System (MEADS) Realignment Plan from MDA to the Army." The Army became the single manager for the PAC-3 missile program with responsibility of interoperability and integration of PAC-3 capability assigned within the overall BMDS architecture. This was followed in August 2004 by the Under Secretary's approval of the Army's plan to combine management, development, and fielding of the PATRIOT and MEADS systems. Combining PAC-3 with MEADS, a developmental system to defend against ballistic and air breathing threats, provides enhanced air and missile defense capabilities, allows knowledge gained in the

development and fielding of PATRIOT to be fused into the MEADS program.

Program Description

Although the Army is now responsible for PAC-3 procurement and the PAC-3/MEADS combined program, the Army and MDA continue to work together to integrate the capabilities into the BMDS. MEADS is a cooperative effort among the United States, Germany, and Italy to develop a netted and distributed air and missile defense system that is mobile and transportable. This system will be capable of countering similar PAC-3 ballistic missiles and air-breathing threats. It will help bridge the gap between short-range maneuver air and missile defense systems and the longer-range BMDS elements. Mounted on wheeled vehicles, MEADS includes launchers carrying multiple interceptors along with advanced radars that will provide 360-degree coverage. PAC-3 and MEADS components will be integrated with the BMDS C2BMC to provide lower tier, terminal defense. Incorporation of the these components with C2BMC allows an integrated fire control of the terminal defense systems and the use of the broad range of BMDS sensors that support integrated fire capability.

Contributions to the BMDS

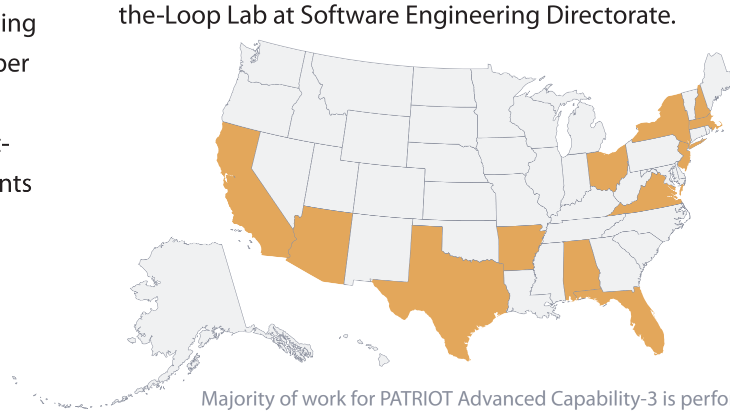
The PATRIOT weapon system provides simultaneous air and missile defense capabilities as the Lower Tier element in defense of U.S. deployed forces and allies. The system is employed with THAAD to provide an integrated, overlapping defense against missile threats in the terminal phase of flight. Jointly, these systems effectively engage the threat while minimizing interceptor wastage by forming a multi-tier theater defense against adversary missile threats using peer-to-peer engagement coordination, early warning track data, and battle management situational awareness. PATRIOT also contributes to BMDS situational awareness by transmitting precision cueing data to other theater elements while simultaneously protecting BMDS assets against short-range ballistic missiles, large-caliber rockets, and air-breathing threats. For homeland defense, PATRIOT provides detection, track, and engagement of short-range ballistic missiles and cruise missiles. These engagements are further enhanced by networked BMDS remote sensors that supply early warning data to increase the probability of success. PATRIOT has added Upper-Tier Debris Mitigation capability to mitigate the excessive radar load and potential missile waste caused by debris from upper-tier intercepts.

Testing

To support PATRIOT's next major planned software upgrade, PATRIOT successfully executed a ground test campaign and several flight tests during 2008. With participation in the BMDS Ground Test-03 Campaign, the PAC-3/Configuration-3 system defeated all assigned threats in a representative engagement scenario while providing theater-level situational awareness to higher echelon unit commanders. Four flight test missions: two against multiple air-breathing threats, one against a theater ballistic missile, and one against two theater ballistic missiles and an air-breathing threat, were successfully executed. PATRIOT successfully conducted the first PAC-3 Controlled Test Flight (CTF) of the Missile Segment Enhancement (MSE) missile, participated in a THAAD flight test, and was involved in multiple test flights of Japanese and German PATRIOT programs. PATRIOT also successfully conducted several tests for the following additional capabilities: interoperability improvements, radar multi-functional improvements, IFF Mode 5 limited implementation, TBM mission tailoring and discrimination improvements.

2008 Accomplishments

- Conducted Missile Flight Tests: E-48 (3-ABT), E-49 (2-ABT), ATM-49 (1-TBM) and ATM-50 (2-TBM & 1-ABT), and first successful CTF of a PAC-3 MSE missile.
- Conducted Upper Tier Debris Mitigation algorithm testing in GT-03 and FTT-10 pre-mission work.
- Supported NATO testing efforts by providing Extended Air Defense Simulation data, using NATO scenarios, and implementing PATRIOT Link 16 message bit to connect the ALTBMD Test Bed to MDA and the PATRIOT Hardware-in-the-Loop Lab at Software Engineering Directorate.



Majority of work for PATRIOT Advanced Capability-3 is performed in the colored states.

Kinetic Energy Interceptor

MISSION

The mission of the KEI program is to develop and field a strategically deployable, tactically mobile, land- and sea-based capability to defeat medium- to long-range ballistic missiles during the boost, ascent, and midcourse phases of flight. Land- and sea-mobile capabilities will use hit-to-kill technologies and a high acceleration, common booster.

Program Description

KEI is comprised of three major components: a missile launcher, a fire control and communications unit, and a high acceleration interceptor that delivers payloads capable of destroying adversary ballistic missiles and their lethal payloads using hit-to-kill technology. MDA awarded the KEI Development and Test Phase contract to develop common, multi-use capabilities for the next-generation, high performance interceptor weapon system. The KEI program builds upon existing and planned BMDS

sensors, C2BMC technology, and kill vehicle capabilities developed in other program elements. This common design and performance approach is applicable to multiple platforms and provides mobility across the battlespace. The program will reduce risk through a series of verification tests, robust systems engineering, and integration.

Contributions to the BMDS

The KEI program provides a high confidence path to a boost phase defense layer and a flexible, forward-based midcourse capability for the BMDS. The capability to engage threats early, and in combination with later GBI or Aegis BMD engagements, provides additional layers of protection and increases effectiveness against countermeasures for the BMDS. KEI's mobility enables rapid deployment near an adversary's launch sites and subsequent early battlespace engagements of the adversary's ballistic missile. Mobility also provides the operational flexibility to respond to changing adversary conditions (countries, countermeasures, and tactics) and mitigates an adversary's capability to exploit BMDS fixed elements.

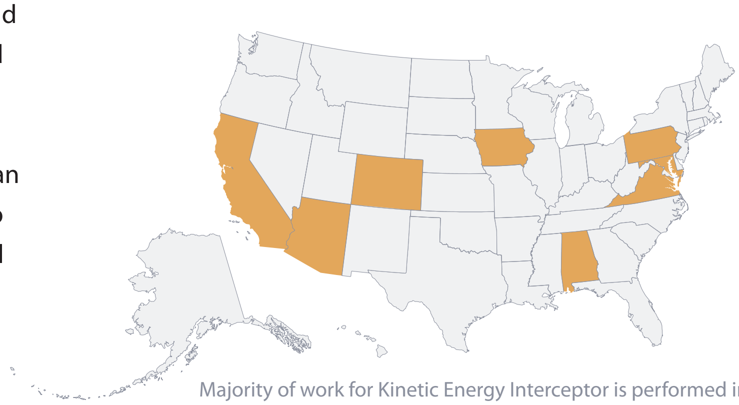
Testing

Not long after program inception, the KEI program adjusted its acquisition approach to focus on demonstration of key technologies before continuing with the originally scheduled development program. These tests focus on the two key items necessary to consummate the stressing boost phase intercept—early launch detection and engagement planning enabled by satellite provided sensor data and booster high velocity and acceleration performance. The program has conducted a fire control development verification test that confirmed satellite-based sensor data can be processed to provide a quality fire control solution in the timeline necessary to consummate a boost phase engagement, provided the booster vehicle can meet its velocity and acceleration requirements. The next step is to confirm booster velocity and acceleration. This development verification test is scheduled for summer 2009. The KEI program has developed a focused development and test plan for the rocket motors and the control system that are needed for the flight vehicle. This plan includes ten static fire tests, five for each of the booster's two stages, and the development of a pathfinder vehicle that will define vehicle build-up, be ground tested, and participate in a simulated launch. Four of the five planned Stage 1 and two of the five Stage 2 rocket motor static fires have been completed. All tests verified the successful performance of the rocket motors under varied environments and loads. A Stage Separation Test was also conducted that characterized the separation shock environment and verified physical separation of the Stage 1 and 2 rocket motors.

At the completion of the 2009 booster verification test, the Agency will have the information needed to decide whether to proceed with the development of this system. Data from the fire control and booster verification tests will provide the initial information required to complete the development, modeling, testing, and analysis necessary to conduct the weapon system acquisition.

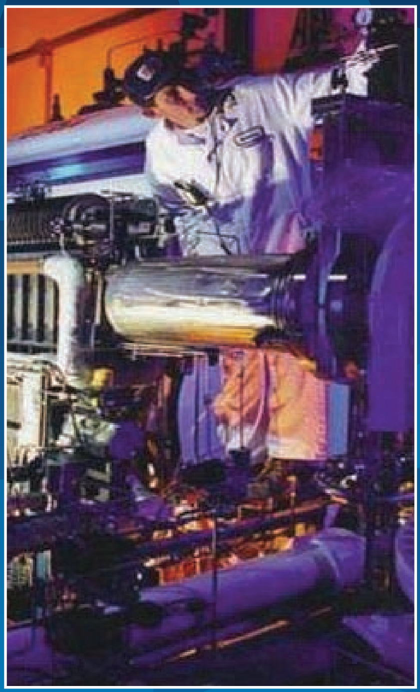
2008 Accomplishments

- Incorporated design changes to Stage 2 rocket motor based on motor proof of concept test data.
- Initiated final integration and test of the booster pathfinder vehicle.
- Completed planned qualification testing for avionics, ordinance, and structures to certify components for the Booster Flight Vehicle.
- Completed a Canister Preliminary Design Review (PDR) to ensure that the design meets performance specifications.
- Supported warfighter in Nimble Titan 08 Wargame.



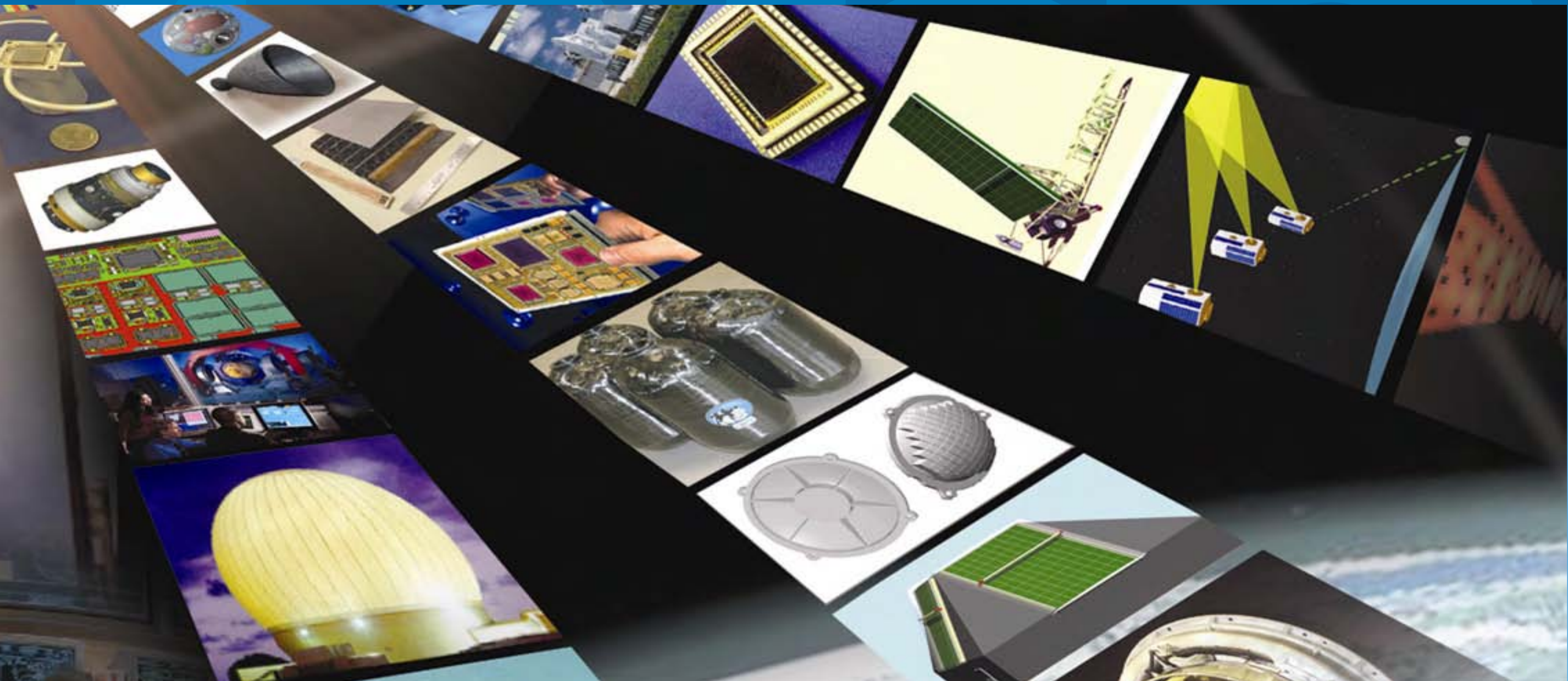
Majority of work for Kinetic Energy Interceptor is performed in the colored states.

Advanced Technology



MISSION

The Advanced Technology Directorate is responsible for identifying and developing new technologies to improve BMDS capabilities. The program promotes investments to support iterative development of the BMDS with minimal acquisition risk, and it offers both evolutionary and revolutionary improvements to outpace tomorrow's ballistic missile threat. Advanced Technology also leads a national effort to develop algorithms for improved target discrimination, sensor data fusion, and battle management capabilities.



Program Description

Advanced Technology, working closely with the BMDS Architect, serves as the focal point for identification and evaluation of advanced concepts with applicability to the BMDS. The Directorate identifies relevant new technologies and concept proposals from individuals, businesses, universities, and international entities through recurring technology-focused Broad Agency Announcements. It also conducts outreach activities and collaborative efforts with industry, academia, and other government agencies and foreign activities. Advanced Technology balances its investments in selected technologies between evolutionary, near-term enhancements and revolutionary, far-term capabilities. The Directorate also promotes the integration of all selected technologies into the BMDS. Technology areas for advanced development include: active and passive sensors, directed energy systems (lasers), portable energy sources, decision and discrimination algorithms, fuels, and materials research.

The Advanced Technology Directorate also assists businesses in developing and transitioning innovative technology for military and commercial use. For this purpose, Advanced Technology leads MDA's Small Business Innovation Research, Small Business Technology Transfer programs, and the Technology Applications Program. Through these programs, the Advanced Technology Directorate supports product development and partnerships, and assisting in securing private funding. The Program's efforts improve the technological maturity of a business' product while sharing cost and risk.

Contributions to the BMDS

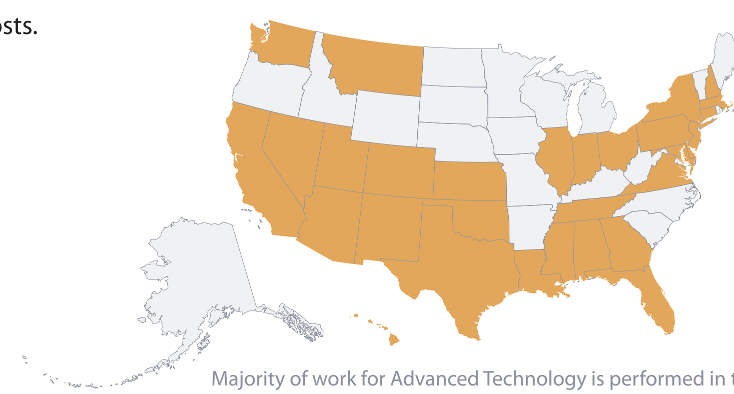
The Advanced Technology Directorate offers the potential for dramatic improvements in BMDS capabilities faced with an evolving ballistic missile threat. The Directorate stimulates innovation through "outside-the-box" thinking. The new and innovative concepts and technologies that it seeks out and develops can be applied across the BMDS to stay ahead of the threat, improve system performance, and lower life cycle costs.

Testing

- 2008 tests included:
- First ever ballistic missile intercept during boost phase using Netcentric Airborne Defense Element (NCADE) seeker.
- Demonstration of passive sensors using Quantum Well Infrared Photodetector (QWIP) camera during missile firing tests, resulting in longer range and better image quality.
- Demonstration of Corrugated-Quantum Well Infrared Photodetector(QWIP) Focal Plain Array (FPA), resulting in better sensor quality; transitioned to Army's Night Vision Laboratory.
- Demonstration of Strategic Illuminator Laser prototype; transitioned to the Air Force.
- Stress testing of BMDS algorithms.
- Future Capability conceptualization of air launched interceptor engagements of ballistic missile threats in dome simulators during joint wargames.
- Testing of algorithms for system level discrimination and clutter mitigation; transitioned these for use in space-based tracking systems and the SPY-1 Radar.

2009 Anticipated efforts include:

- Testing to validate improved sensor capability of the 2000 x 2000 pixel 2-Color QWIP camera during ballistic missile flights.
- Testing to transfer technology to NASA's James Webb Space Telescope.
- Participation in ballistic missile flight tests to improve Modeling and Simulation, collect phenomenology data, and incorporate the data into Agile Kill Vehicle efforts.
- Hot Fire Testing to demonstrate developmental kill vehicle maneuvering capabilities using full scale heavyweight green liquid propellant (HAN) thrusters.
- Testing to demonstrate and transition algorithms for system-level tracking and expanded clutter mitigation.



Majority of work for Advanced Technology is performed in the colored states.

"There is no way to ignore efforts by rogue states such as North Korea and Iran to develop and deploy nuclear weapons, or Russian or Chinese strategic modernization programs. As long as other states have or seek nuclear weapons—and potentially can threaten us, our allies, and friends—then we must have a deterrent capacity that makes it clear that challenging the United States in the nuclear arena—or with other weapons of mass destruction—could result in an overwhelming, catastrophic response."

Quote from speech delivered by Secretary of Defense Gates at the Carnegie Endowment for International Peace on 28 October 2008

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